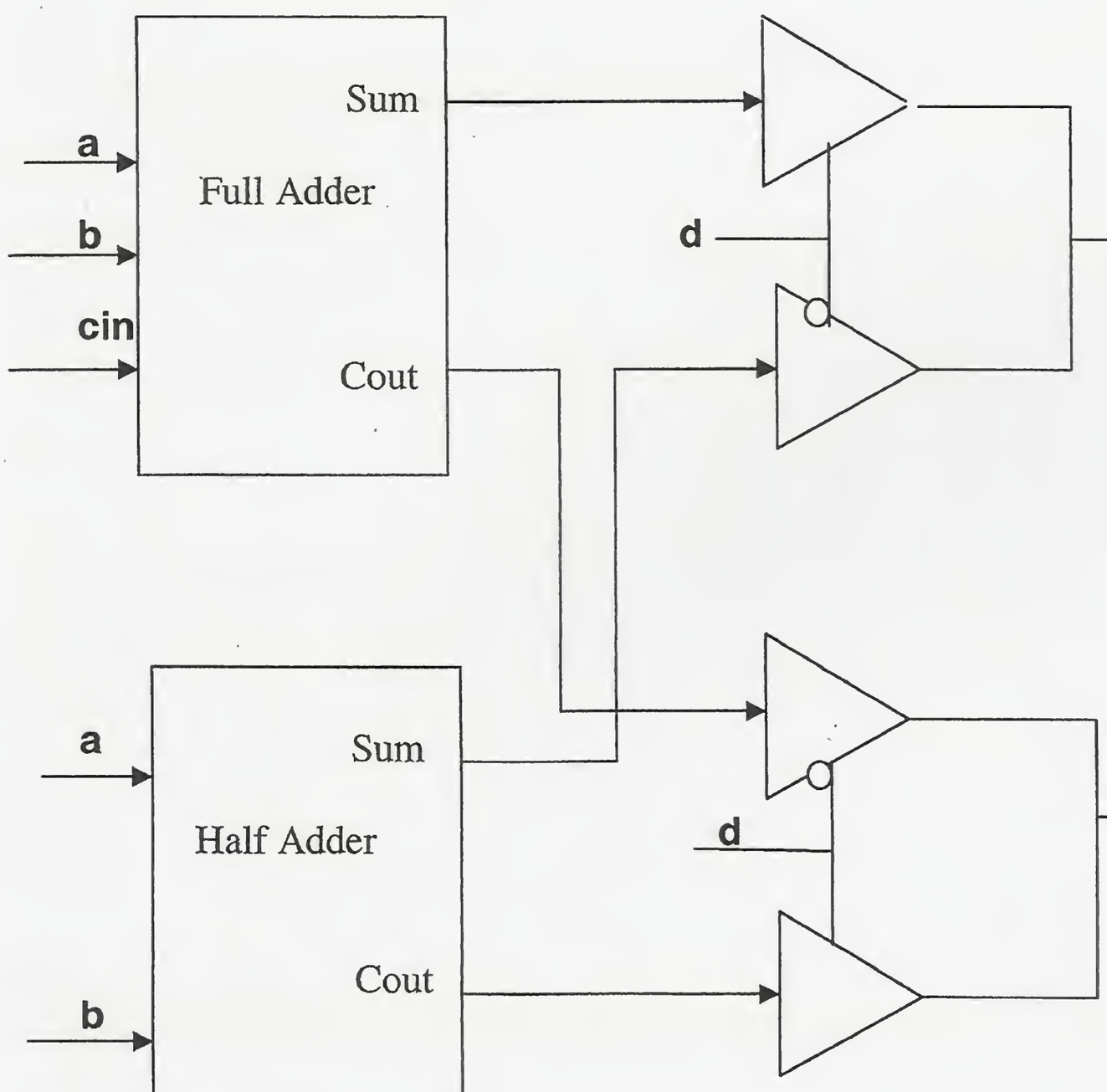
10

Question [1]: [12 mark]

Write the equations of the functions F1 and F2 generated by the following circuit.

H.A



a b	sum	cout
0 0	0	0
0 1	1	0
1 0	1	0
1 1	0	1

$Sum = a \oplus b$

$cout = ab$

Sum =

$F_1 = (a \oplus b \oplus cin) \cdot \bar{d} + (a \oplus b) \cdot d$

F.A

a b cin	sum	cout
0 0 0	0	0
0 0 1	1	0
0 1 0	1	0
0 1 1	0	1
1 0 0	1	0
1 0 1	0	1
1 1 0	0	1
1 1 1	1	1

$Sum = \bar{a}b\,cin + \bar{a}b\bar{cin} + a\bar{b}\bar{cin} + abcin$

$= \bar{a}(\bar{b}cin + b\bar{cin}) + a(\bar{b}\bar{cin} + bcin)$

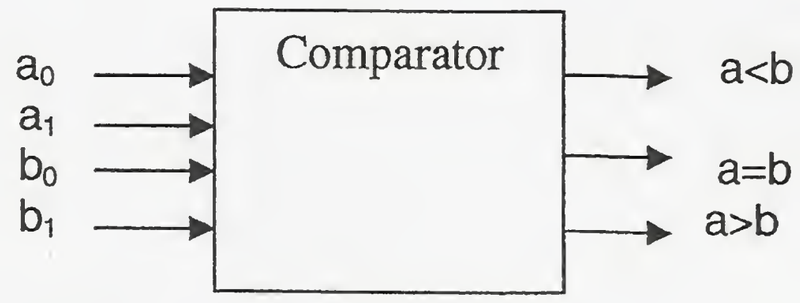
$= a \oplus b \oplus cin$

$cout = a + b\,cin$

$F_2 = (a + b\,cin) \cdot \bar{\bar{d}} + (a\,b) \cdot d$

Question [2] : [12 marks]

We want to design a 2-bit word comparator that compares the word $a = a_0\, a_1$ with the word $b = b_0\, b_1$.



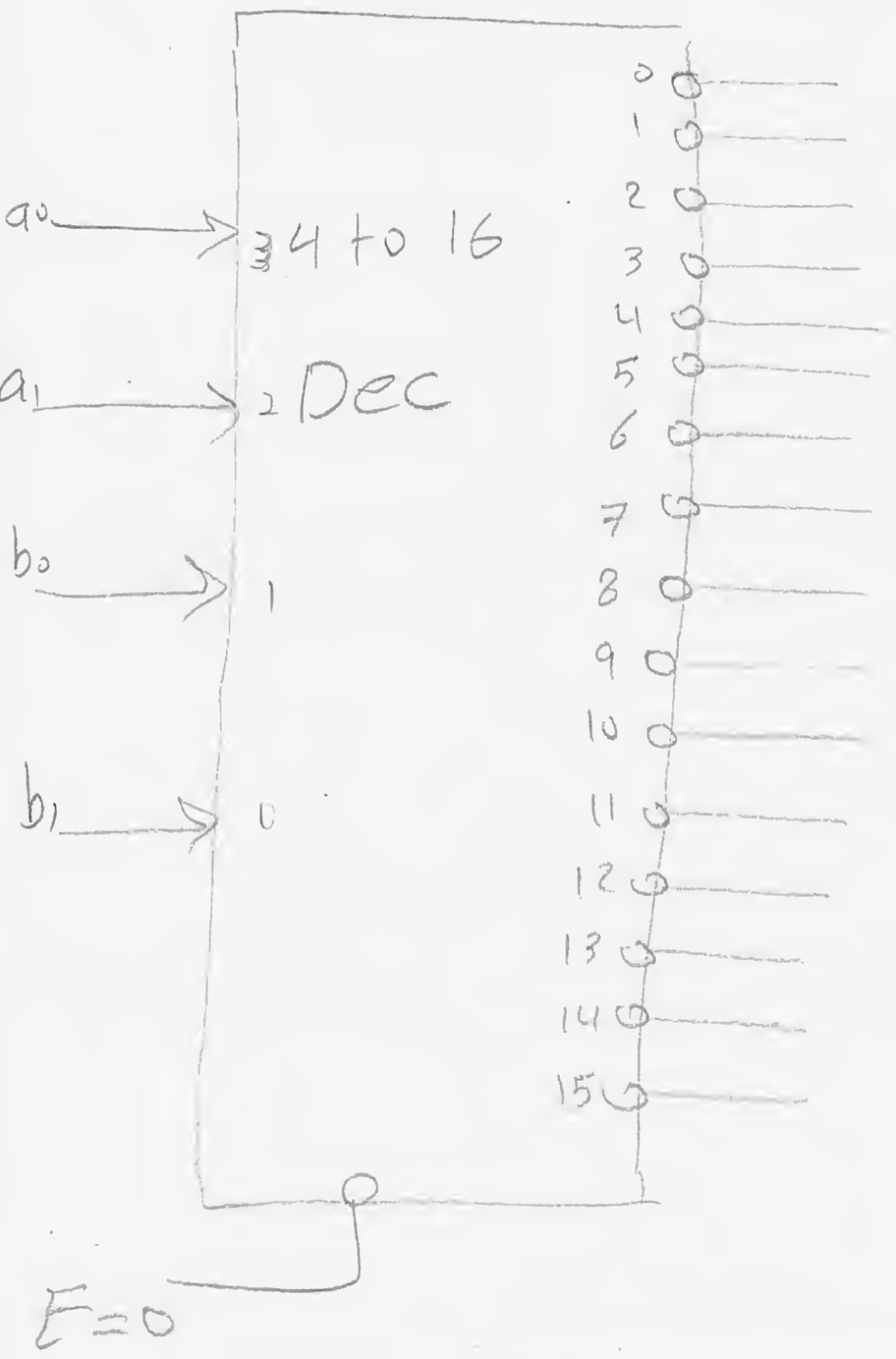
8 4 2 1

1)Give the truth table of the comparator.

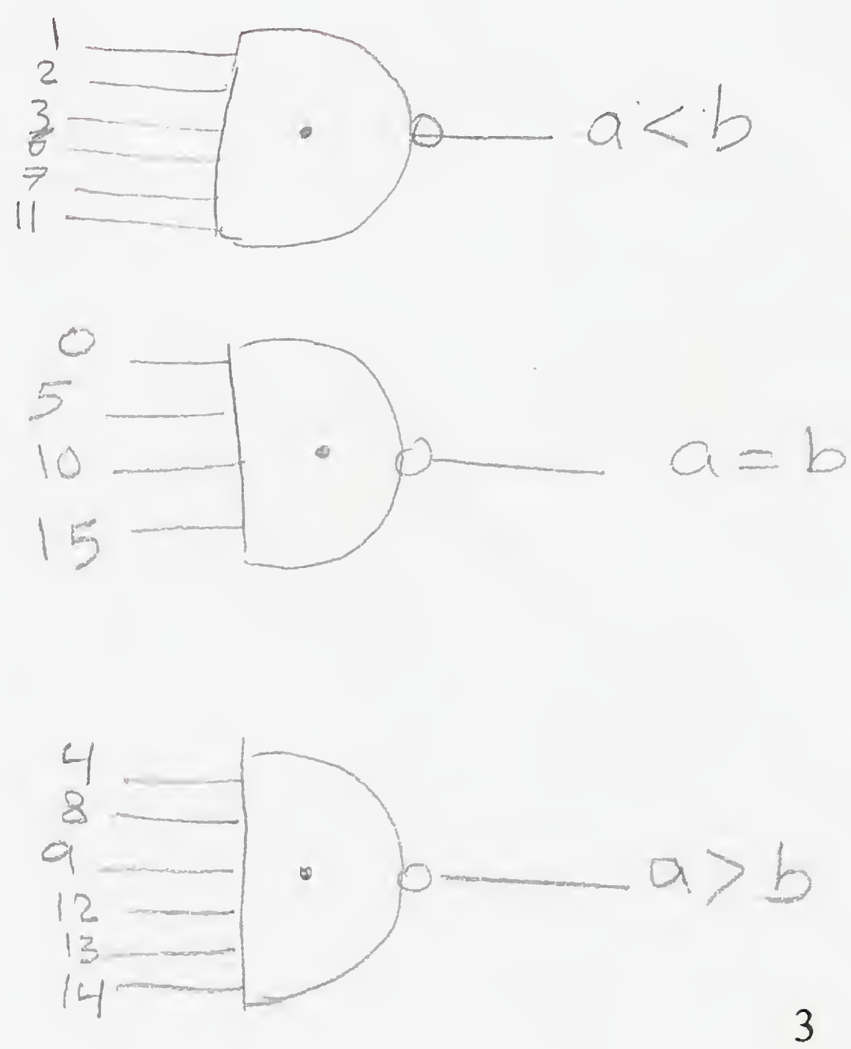
$a_0a_1b_0b_1$	a<b	a=b	a>b
0 0 0 0	0	1	0
0 0 0 1	1	0	0
0 0 1 0	1	0	0
0 0 1 1	1	0	0
0 1 0 0	0	0	1
0 1 0 1	0	1	0
0 1 1 0	1	0	0
0 1 1 1	1	0	0
1 0 0 0	0	0	1
1 0 0 1	0	0	1
1 0 1 0	0	1	0
1 0 1 1	1	0	0
1 1 0 0	0	0	1
1 1 0 1	0	0	1
1 1 1 0	0	0	1
1 1 1 1	0	1	0

5

2) Implement the comparator with a decoder with inverted outputs and only NAND gates.



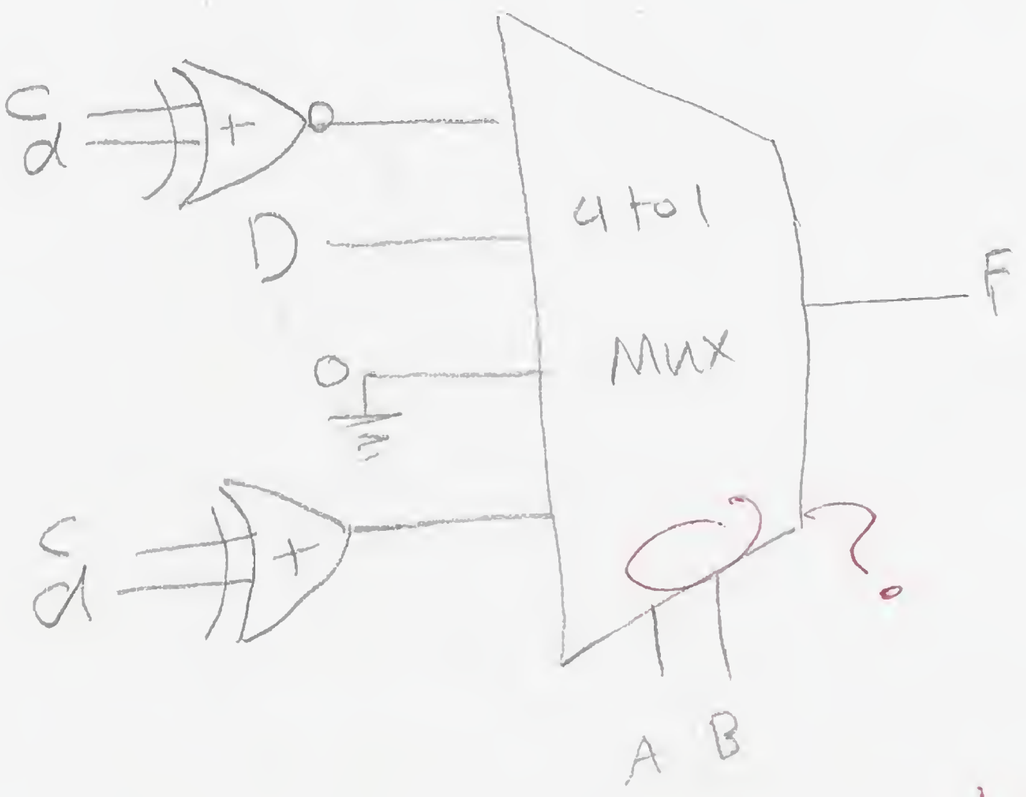
7



3

Question [3]: [12 marks]

a. Implement F= Σm(0,5,13,14) + Σd(3,7,11) with a 4 to 1 Multiplexer and a minimum number of gates.



	a	b	c	d	F
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	X
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	X
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	X
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	0

$I_0 = \bar{c}\bar{d} + cd$ over $c \oplus d$

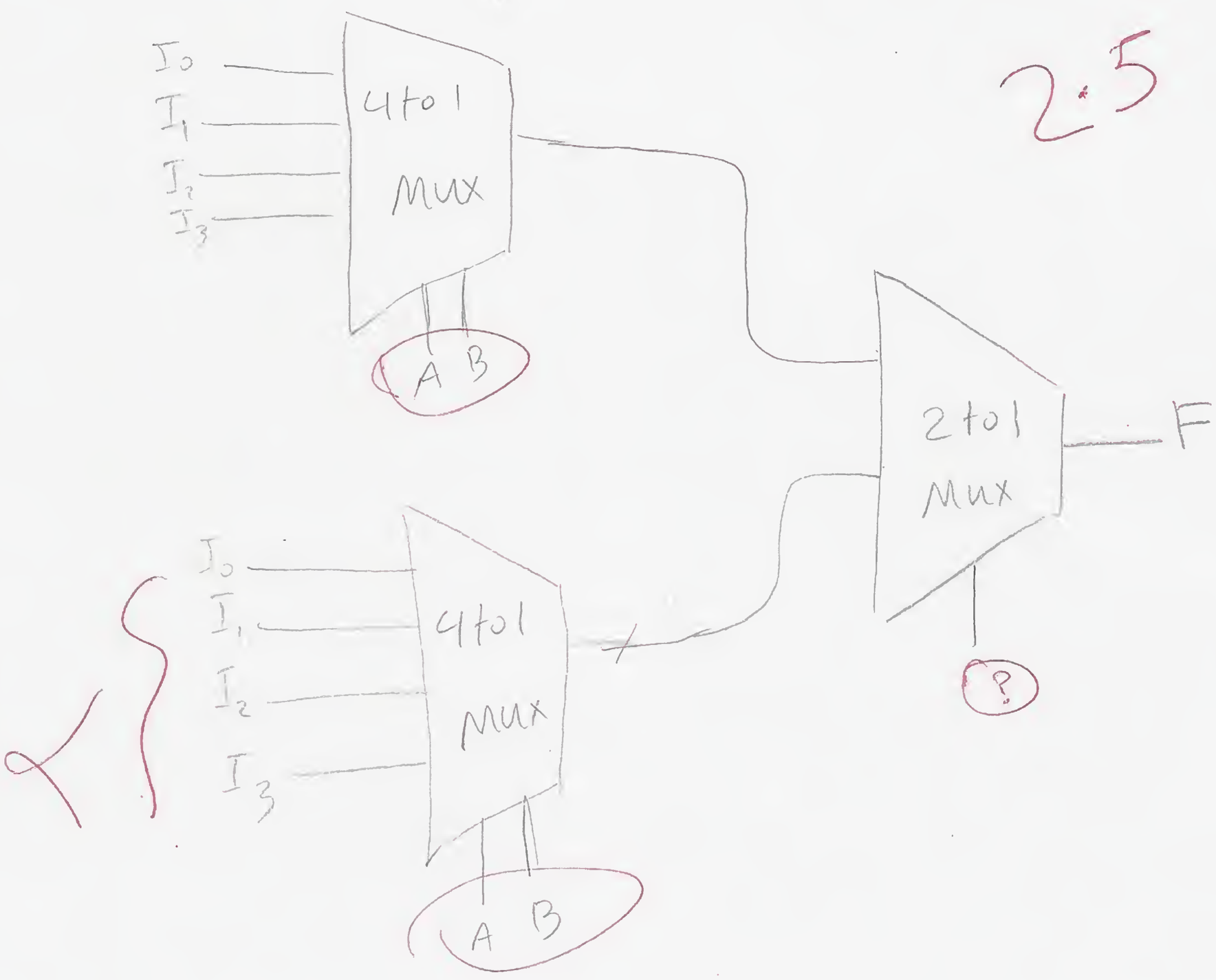
$I_1 = D$

$I_2 = 0$

$I_3 = c\bar{d} + \bar{c}d$ over $c \oplus d$

8

b- Show how to make an 8 to 1 Mux by using a number of 4-to-1 Muxs and one 2-to-1 Mux.



2.5

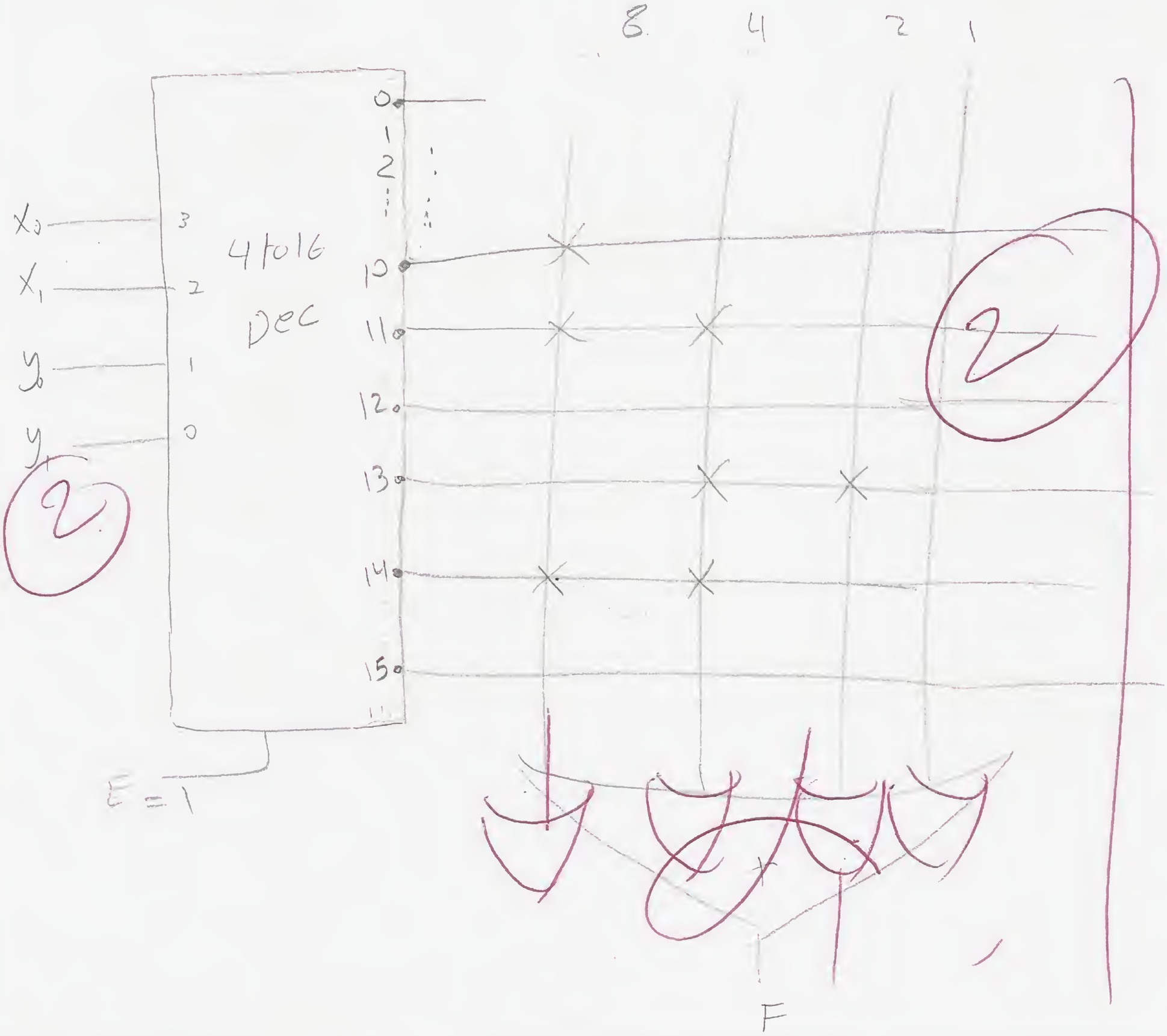
Question [4]: [12 mark]

a. Construct the truth table of a ROM to implement the function F= 2 X Y. Where X and Y are 2-bit binary numbers.

X_0	X_1	Y_0	Y_1	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	2
0	1	1	0	4
0	1	1	1	6
1	0	0	0	0
1	0	0	1	4
1	0	1	0	8
1	0	1	1	12
1	1	0	0	0
1	1	0	1	6
1	1	1	0	12
1	1	1	1	18

3

b. Draw the internal structure of the ROM showing only the last 5 memory lines (words).



Question [5]: [12 mark]

a) Derive the next state (characteristic) equation for T- Flip-Flop.

T Q	Q^+
0 0	0
0 1	1
1 0	1
1 1	0

T / Q^+	0	1
0 0	0	0
0 1	0	1
1 1	0	0
1 0	0	1

4

$Q^+ = T \oplus Q$

b) Complete the following timing diagram for the following J-K Flip Flop.

PreN Clk
0 0 → Not allowe
0 1 → 1
1 0 → 0
1 1 → JK

JK
0 0 → Q No change
0 1 → 0 Rest
1 0 → 1 set
1 1 → $\bar{Q}$